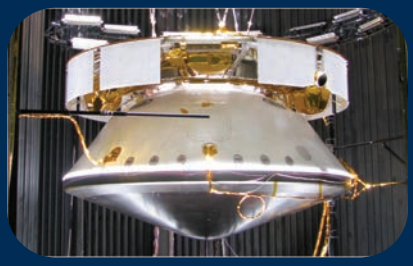
NASA JPL Uses MAYA-authored Thermal Simulation Tools to Design the Next Generation Mars Rover



About Jet Propulsion Laboratory

The Jet Propulsion Laboratory (JPL) is a federally funded research and development center managed by the California Institute of Technology for the National Aeronautics and Space Administration. JPL is the lead U.S. center for robotic exploration of the solar system. JPL's history of space exploration and discovery spans 50 years, from the early Explorer 1 spacecraft, to the latest missions to Mars.

About the Mars Science Laboratory

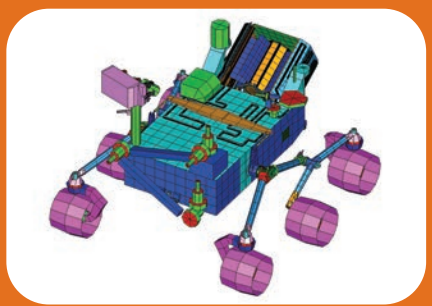
The Mars Science Laboratory (MSL) is a 3 year mission to explore the surface of Mars with a new, advanced rover. The mission is scheduled to launch in late 2011 from the Kennedy Space Center in Orlando, Florida. Once on Mars, the aptly named "Curiosity" rover will spend at least 2 years surveying the landscape, and help scientists back on Earth determine if the climate on Mars was ever suitable to sustain life.

Challenge

Complex CAD geometry poses several challenges to the thermal engineer. How can the thermal design and analysis of the Mars Science Laboratory proceed concurrently with the mechanical design? How can design iterations be propagated efficiently without manual rework? And, how can the final thermal design be captured and sent seamlessly to manufacturing?

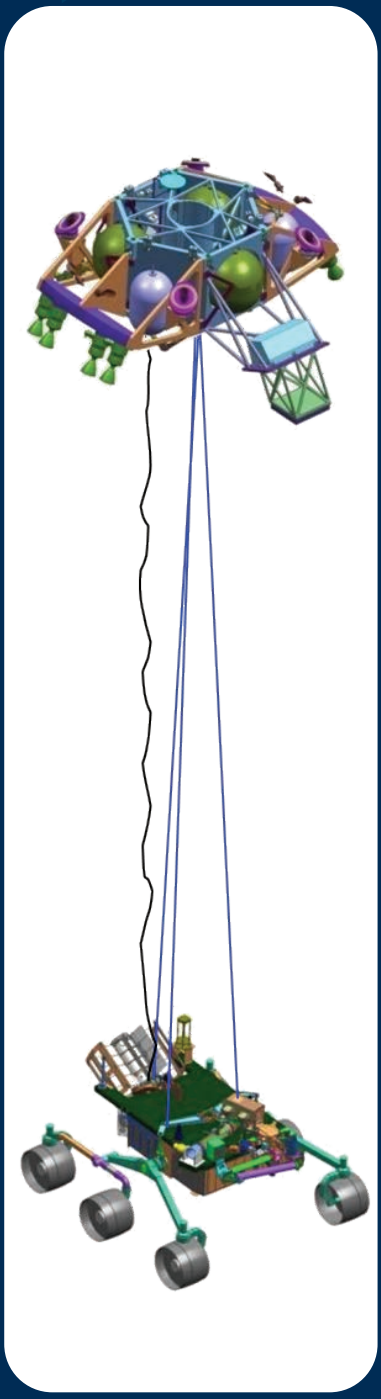
Solution

The MAYA-authored thermal analysis software package provides efficient conversion of CAD parts to simplified geometry to thermal models completely within the NX environment. The thermal analysis simulates a variety of physical effects, such as fluid flow in the Mars rover, heater control of the propulsion system, and solar loading of the cruise stage. The analysis results were used to update the rover design, and this updated design was subsequently sent for manufacturing.



Result

MAYA-authored software helped JPL develop the thermal design, predict the system thermal response and assist the validation process of the entire MSL flight system, while increasing design collaboration and minimizing test time.



Design complexity

One of the major, and unique, difficulties inherent in space system design is that designs have to work as intended the first time they are deployed. When the experts at JPL began to design the next generation Mars rover, they had to contend both with this challenge and the complexity of the MSL vehicle design itself.

6 minutes of terror, 2 years of exploring

As the MSL vehicle enters Mars' atmosphere the velocity will decrease from approximately 19,000 kph to 1,600 kph, and the rover will experience an estimated peak temperature of 1,447° C. Inside the atmosphere, the rover will be parachuted closer to the surface. Once close enough, the Descent Stage will initiate its rocket thrusters and gently lower the 950 kg rover onto the surface, detach and fly away. When these "6 minutes of terror" are over, the 2 year long Surface Mission phase will begin and the rover will have to contend with harsh solar winds and surface temperatures that fluctuate between -135° C and +50° C.

Accuracy and integration

With MAYA-authored software, JPL has access to a powerful and accurate Computer-Aided Engineering (CAE) tool integrated with an extensive Computer-Aided Design (CAD) environment. This gave the MSL mission two major advantages that together resulted in significant productivity gains.

MSL Mission Phases and Durations

Launch:	40 minutes
Cruise/Approach:	9-10 months
Entry, Descent, Landing:	15 minutes
Surface Mission:	2 years

Firstly, the integrated environment minimized the time between design iterations and allowed the engineering teams to rapidly evaluate multiple designs. By keeping model designs and finite-element meshes used for simulations in a single environment, collaboration between the design and analysis teams increased while effort spent on model reconstruction was greatly reduced.

Secondly, it resulted in efficient model correlation. Because the Mars surface environment cannot be accurately simulated in test chambers, the simulation model was calibrated with test results, and the calibrated simulation model was used to analytically validate the rover thermal design. The ease and efficiency of going from a design simulation model with flight-like environments, to test simulation model with test chamber conditions, and then back to a design simulation model for flight validation, sped up the process considerably.

The MAYA-authored software and its seamless integration with the NX environment helped JPL turn design complexity into design confidence.

About MAYA

MAYA, a recent recipient of the NASA Group Achievement Award for "Exceptional strategic thermal software customer support to JPL", is a leading provider of simulation software and technical services for digital product development. As a development partner for Siemens PLM Solutions, MAYA's solutions are deployed worldwide and across a wide array of industries. *http://www.mayasim.com/*

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